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Assessment of heavy metals in vegetables and cereals collected from local market, Mumbai

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Abstract
In the present study, the locally available vegetables and cereal evaluated for the presence of Heavy metals. The present investigation reveals with the assessment of heavy metals in selected cereals and green vegetables available in the local market with contaminated water. All the samples were analyzed using Atomic Absorption Spectrophotometer. The obtained results revels that concentrations of metals were exceeding than the recommended maximum acceptable levels. The concentration of heavy metals in wheat gains was found to be in the order of Cu>Zn<Ni< Cd. High concentrations of heavy metals in different parts of the vegetables might be related to their concentration in the polluted air with industrial activities. The study concludes that atmospheric depositions and marketing systems of vegetables play a significant role in elevating the levels of heavy metals in vegetables having potential health hazards to consumers of locally produced foodstuffs.

Keywords: heavy metals; atomic absorption spectrophotometer; vegetables and cereals

Introduction
Heavy metals are environmental contaminants capable of causing human health problems if excess amount is ingested through food heavy metals are non biodegradable and persistent, have a long biological half lives and can be bio-accumulated through biological chains (Zhou *et al.,* 2016) [11]. Heavy metal toxicity may occur due to contamination of irrigation water, the application of fertilizer and metal based pesticides, industrial emission, harvesting process, transportation, storage or sale. Crops and vegetables grown in soils contaminated with heavy metals have greater accumulation than those grown in uncontaminated soils (Sharma *et al.,* 2009) [5]. This is because farmlands situated in industrialized areas are prone to pollution by the release of chemicals into the farmlands leading to contamination of plant crops (Sharma *et al.,* 2008) [4]. Heavy metal contamination in cereals and vegetables cannot be underestimated as these foodstuffs are important components of the human diet. The cereals most commonly cultivated in this region are wheat, Jawar, Barley, Sorghum, Rice, Sajji etc. These cereals are the important as well as very nutrient grains. Also is more stable food for most people of the area. Cereals are needed for a healthy diet because cereals derived products are recommended due to their contents such as fiber, trace minerals, and vitamins, which support to prevent various diseases. But, Heavy metals contamination in food products more than tolerance limit leads adverse effect on health. The cereals are rich in carbohydrates, protein etc., and act as sources of energy. Therefore, they are essential and useful for a well-balanced healthy diet. Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial antioxidative effects. However, intake of heavy metal-contaminated vegetables may pose a risk and pose a direct threat to the human health. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance (Singh *et al.,* 2006: Ramteke *et al.,* 2016: WHO, 1993) [6, 3, 9]. Heavy metals are among the major contaminants of food and may be a major problem to environment. The heavy metals may enter the human body through consumption of contaminated drinking water, consumption of food plants, cereals and green vegetables grown in the metal contaminated soil and sediments. Heavy metals are potential environmental contaminants of causing human health problems if present in a higher percentage of the food grains. The heavy metals showed toxic effects even at very low concentration (WHO, 2004) [10]. Heavy metals are non-biodegradable and persistent, have long biological half-lives and they can be bioaccumulated through the biological chains (Khan *et al.,* 2008) [2]. Soil – plants, green vegetables and food leading to unwanted side effects. The high amount of heavy metals in environment represents a potential danger to human health due to their extreme toxicity. Heavy metal contamination may be occurred due to the irrigation with contaminated water from municipal wastes, industrial effluents, the addition of inorganic fertilizers, metal based pesticides and agricultural practices (Chabukdhara *et al.,* 2016) [1]. Crops and green vegetables grown in soils contaminated with heavy metals have a greater accumulation of heavy metals than those grown in uncontaminated soil. Many researchers emphasized the toxic effects of heavy metals to the human body (Tripathi, 1997) [7]. The elements such as Cd, Cr and Arsenic are considered as carcinogenic (cancer producing elements), while Fe, Cu, Zn, Ni and Mn are considered as essential elements. But, these elements are found in higher than their permissible limits may create a toxic effect in human (Türkdoğan, 2013) [8].

Materials and Methods
Collection of samples
A total of six samples of vegetable were purchased from the

central place of Kalina, Mumbai. The collected samples were washed with distilled water to remove the dust particles. Then samples were cut into small pieces using a clean knife. Edible portions of the samples were used for analysis; the leafy vegetables included Spinach (Palak), Fenugreek (Methi), Radish (Mula), Coriander (Kotambari) and cereals (*Triticum aestivum*, *Oryza sativa*). All the samples were collected and stored in polyethene bags until analysis under refrigeration condition (<10^0C). The samples for analysis were then dried using the oven dry method at 105^0C for 24 hours (AOAC, 1990), and a mixture grinder was used to powder the samples while preventing oven heating. About 1 g of the samples were weighed and digested in a mixture of 5 ml of HCl, 2 ml of Conc H_2SO_4 and 20 ml of Conc. HNO_3 in a conical flask under a fume hood. The content was mixed and heated gently at 180^0C – 220^0C for about 30 min on a hot plate. The content was heated until dense white fumes appear.

It was then heated strongly for about 30 min then allowed cooling before making up to the mark in 50 ml volumetric flask. This digested solution used to determine the micro-nutrients like Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Nickel (Ni) and Zinc (Zn) by using Atomic Absorption Spectrophotometer (Elico). The instrument setting and operational conditions were done in accordance with the manufacturers' specifications.

Experimental procedure for metals determination

The working standard solutions were prepared by diluting a stock solution (1000 ppm, AAS grade standard) with ultra-pure water for heavy metal determination. These solutions were frequently run to construct the calibration curves with the help of AAS. Quality assurance measures included the calculation of method detection limit, inclusion of recovery and analysis of standard reference material.

Appropriate drift blank was also taken before the analysis and necessary correlation was made during the calculation of concentration of different elements (49). Hydride Generation technique in Atomic Absorption Spectrometer was used to determine the concentration of As and Hg in the samples.

Table 1: List of common vegetables and Cereals included in the present Study

Part of vegetable / cereal	Common name	Botanical name	Family
Leaf	Spinach (Palak)	*Spinacia oleracea* L.	Amaranthaceae
Leaf	Fenugreek (Methi)	*Trigonella foenum-raecum* L	Fabaceae
Stem	Radis (Mula)	Raphanus sativus L.	Brassicaceae
Leaf	Coriander (Kothimbir)	*Coriandrum sativum L.*	Apiaceae
Grain	Wheat	*Triticum aestivum L.*	Poaceae
Grain	Jowar	*Sorghum bicolor* L.	Poaceae
Grain	Rice	*Oryza sativa L.*	Poaceae

Table 2: Concentrations of heavy metals in green vegetables and Cereals

Botanical name	Cd	Cr	Co	Cu	Pb	Ni
Spinacia oleracea L. (Spinach)	0.62	0.32	0.19	1.2	0.61	0.19
Trigonella foenum-raecum L (Fenugreek)	0.50	0.28	0.17	1.7	0.64	0.22
Raphanus sativus L. (Radis)	0.47	0.32	0.11	1.1	0.57	0.24
Coriandrum sativum L. (Coriander)	0.30	0.18	0.09	1.3	0.39	0.19
Triticum aestivum L. (Wheat)	ND	0.23	0.23	2.1	0.28	0.14
Sorghum bicolor L. (Jwar)	ND	0.16	0.28	2.4	0.23	0.16
Oryza sativa L. (Rice)	ND	0.27	0.15	2.3	0.28	0.11

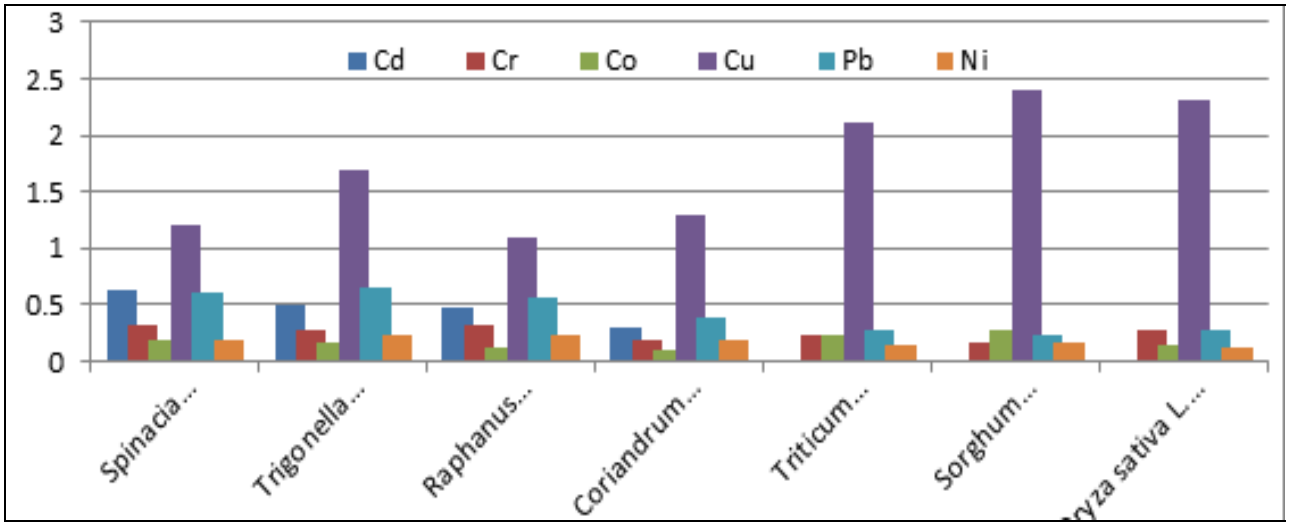
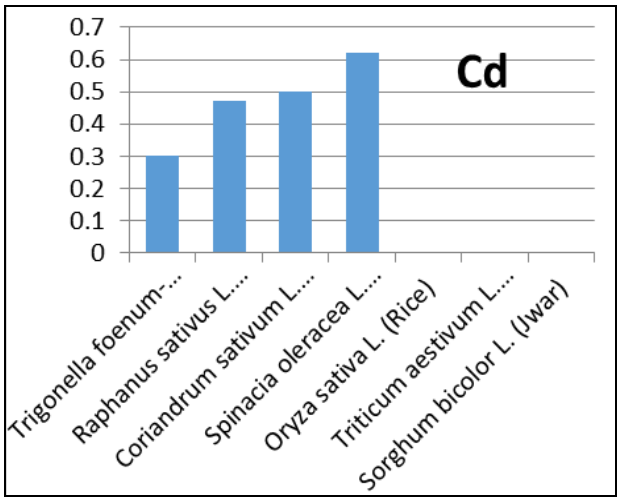
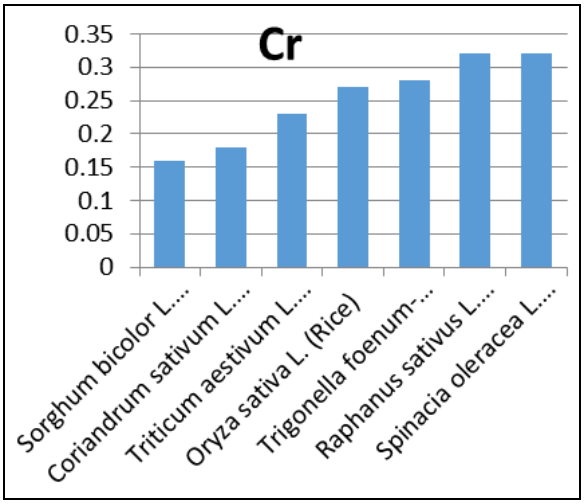


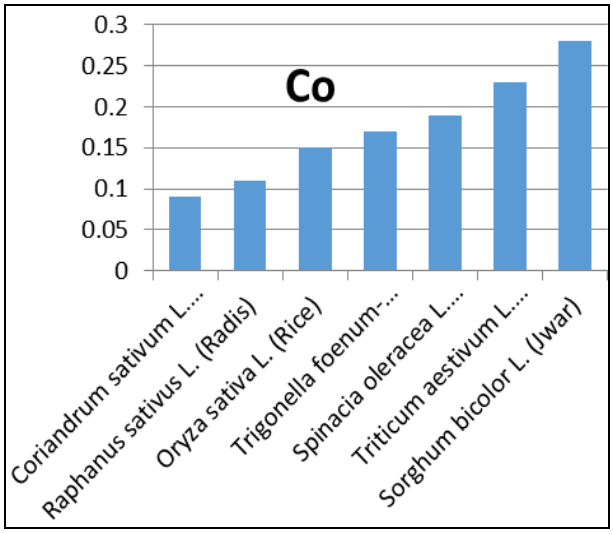
Fig 1: Concentrations of Cd, Ni, Pb, Co and Cr in vegetables



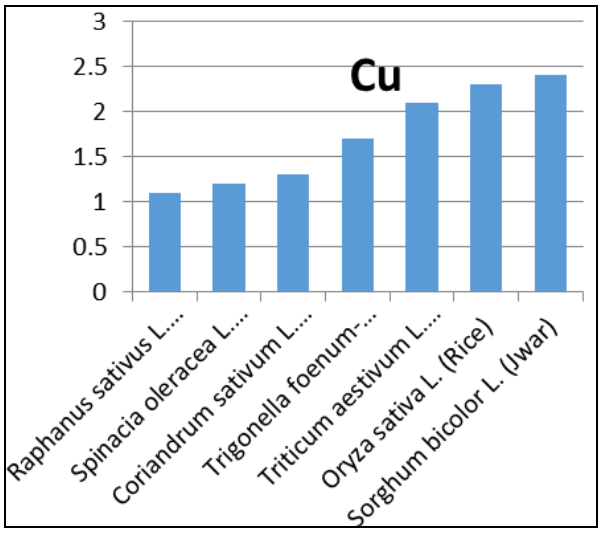
A. Cadmium concentration in Vegetables and Cereals



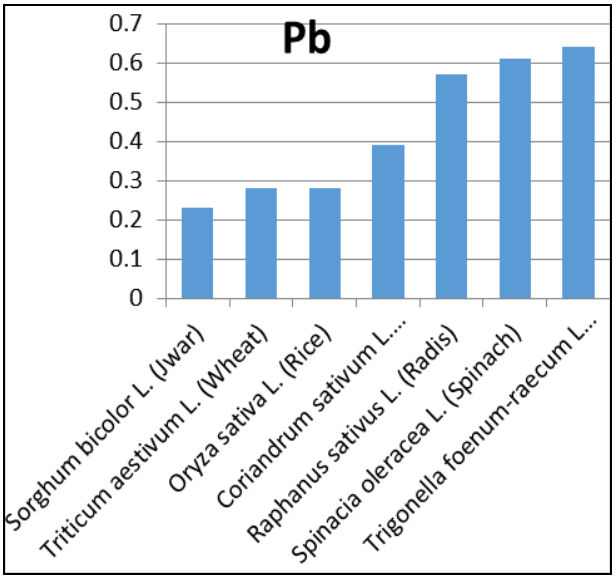
B. Chromium concentration in Vegetables and Cereals



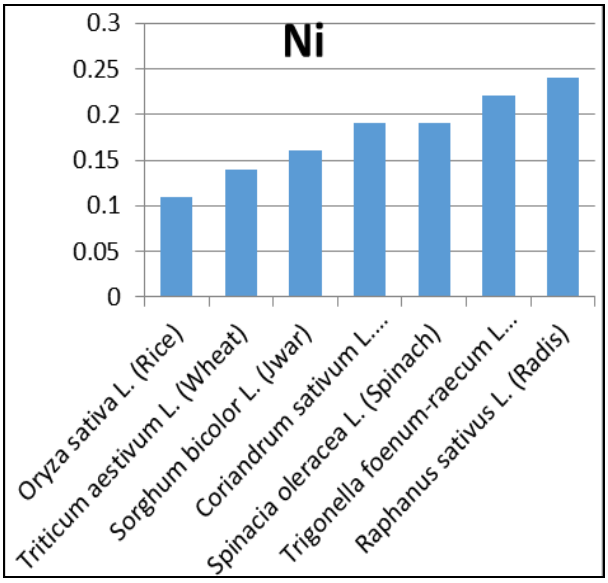
C. Cobalt concentration in Vegetables and Cereals



D. Copur concentration in Vegetables and Cereals



E. Lead concentration in Vegetables and Cereals



F. Nickel concentration in Vegetables and Cereals

Fig 2

Results of heavy metal concentrations in vegetables and cereals in Mumbai City shown in Table 2. The cultivation lands located nearer to the dumping spot (0.30 km) of municipal wastes / sewage wastes from Mumbai Urbanized and Industrial towns to the stream of the river. In addition to this forming community were using fertilizers, pesticides for growing these cereals. Hence, the soil will be affected by the accumulation of these heavy metals. Most of the metals found in Wheat, Rice and Jawar grains were higher than the International standards. The heavy metal concentrations in the food grains (cereals) of the cultivation lands of these regions were found in higher ranges were due to agricultural practices, uses of fertilizers and pesticides. The Co, Ni, Cr, Pb and Cd were under the safe limits. The farming community of village and authorities of the municipal council of Mumbai were informed and recommended that municipal waste water treatment must be carried out prior to dumping directly or indirectly into the stream of the river to avoid soil and food grains toxicity by heavy metals. The results reported here confirm that the vegetables collected from chosen production and marketplaces in the Mumbai city contained heavy metal contents within the safe limits prescribed by the WHO. But Lead, Cadmium and Iron exceeded the tolerance level. The heavy metal concentration in available vegetables leads toxic effect to body system and causing health hazards.

Conclusion

The present study focused on the contamination of heavy metal residues in selected vegetable and cereals collected from open urban market. The most noticeable evil associated with urbanization and industrialization in a haphazard and unplanned manner has resulted in the release of trace metals in the local environment. Elevated level of trace metal contents was observed in vegetables and cereals especially in leafy and root vegetables that sold in the open market that located nearby industrial area, which could be potential health concern to the local resident. It is proposed that tracing of heavy metals in vegetables and other foods should be considered in human food chain. Appropriate precautions should also be taken at the time of transportation and marketing of vegetables and cereals as well as during food processing in kitchen.

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